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Lightning Protection

FOR THE FARM

Farmers' Bulletin No. 2136
U. S. DEPARTMENT OF AGRICULTURE

This bulletin is designed to inform you about the principles of lightning-protection systems so that you can decide on your lightning-protection requirements, discuss your plans with installation experts, survey the completed installation systematically, and make periodic inspections of the installation.

It is not recommended that any person plan or install lightning-protection systems unless he has the necessary training and equipment.

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Lightning Protection
FOR THE FARM

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Lightning is a particularly dangerous threat on the farm.

Every year over 400 persons are killed and over 1,000 are injured by lightning in the United States. Nearly all of these fatalities and injuries occur in rural districts.

Lightning is a major cause of farm fires. In Iowa from 1930 to 1947, fires started by lightning caused an average annual property loss of over $160,000.

Livestock and trees are also major victims of lightning damage.

Lightning protection can save the farmer money in two ways: By preventing loss of life and property, and by reducing the cost of his fire insurance.

THE NATURE OF LIGHTNING

Lightning is electricity that has both high amperage (rate of flow) and high voltage (pressure).

High voltage enables lightning to travel great distances through the air. High amperage is the main reason for lightning's destructive power.

Experiments have proved that a charge of electricity must have a thousand times the voltage of household current to travel, or jump, just 1 foot through the air. Lightning, therefore, which usually travels over 2,000 feet between cloud and earth, must have extremely high voltage. But high voltage without large amperage is relatively harmless. The amperage of lightning discharges between clouds and the earth sometimes reaches 200,000 amperes or more.

Lightning follows the line of least resistance. The air through which lightning must pass between clouds and the earth is an insulating material of high resistance. Materials used in building construction have less electrical resistance than air. When such materials lie between the clouds and the earth, lightning naturally goes along the line of low resistance that they provide.

Lightning-protection systems for buildings give lightning ready-made lines of low resistance. They do this by providing unbroken bodies of material that have lower resistance than any other in the immediate neighborhood. A protection system routes lightning along a known, controlled course between the air and the moist earth. Well-installed and maintained, a lightning-protection system will route lightning with over 90-percent effectiveness.

PROTECTION FOR BUILDINGS

Lightning-protection systems for buildings consist of three parts—air terminals ("rods" or "points"),

[1] Retired June 30, 1958.

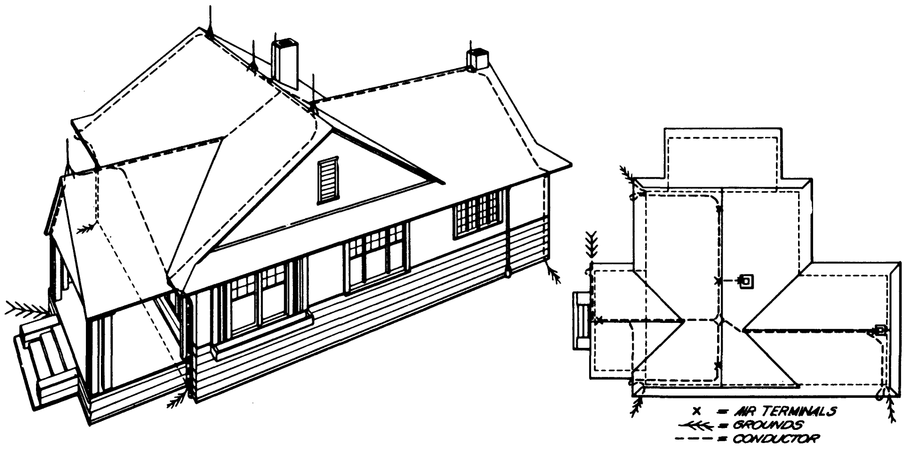

Figure 1.—A typical lightning-protection system installation.

conductors, and ground connections (fig. 1).

All materials used in lightning-protection systems should comply with the specifications of the Code for Protection Against Lightning published by the National Bureau of Standards.

Air Terminals

Air terminals are rods or tubes of metal (fig. 2) that are installed at every projecting high point of a building, such as roof peaks, chimneys, dormers, ventilators, gables, flagpoles, towers, and water tanks.

Terminals are manufactured in various lengths, but usually measure between 10 and 24 inches from tip to base. When terminals are made of copper tubing, they should be at least 5/8 inch in diameter and have a wall thickness over 0.032 inch.

Space the terminals along roof ridges, railings, and parapets according to the length of the terminals. (Recommended spacing also applies to metal-covered roofs.) If they are less than 24 inches long, space them less than 20 feet apart. If they are between 24 and 60 inches long, space them no more than 25 feet apart. There should

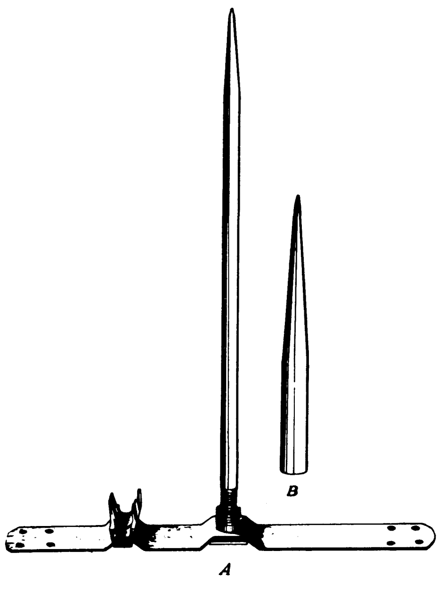

Figure 2.—Common types of air terminals. A, Screw-in mounting. B, Screw-on mounting.

be a terminal within 2 feet of each gable end of any roof.

Short terminals—usually 10 inches long—are satisfactory for projecting parts of a building. They are usually clamped directly to the conductor cable. Longer terminals have bases that are attached to the building, and the conductors are clamped to the bases. Air terminals over 18 inches long are usually supported by metal tripods (fig. 3). Wind, snow, and ice seldom damage well-erected air terminals. Do not mount ornaments and weather vanes on air terminals. They may weaken terminal mountings.

Air terminals on chimneys must be coated with lead to prevent corrosion from smoke fumes. They should project 10 to 24 inches above the top of the chimney (fig. 4).

Silos and towers with peaked tops need 1 or more air terminals; those with flat tops need 2 or more.

Conductors

Conductors are the parts of lightning-protection systems that connect air terminals with grounds. They are made of any good electricity-conducting material that will stand exposure to weather. Aluminum or copper is now used in most installations, instead of the once-common galvanized steel. Aluminum and galvanized steel corrode and lose strength in salt air. Do not use these materials for conductors where salt air is common.

The conducting capacity of a conductor depends on its weight. The minimum acceptable weight, per thousand feet, is: Copper, 187.5 pounds; aluminum, 95 pounds; and galvanized steel, 320 pounds.

The cable form is now more popular than the rod. Cable is easier to install, because it is flexible, and it has fewer joints to interfere with the conducting of electricity (fig. 5).

Install conductors to join air terminals in straight lines, along the face of the gables to the eaves and then down to ground connections (fig. 6). Avoid unnecessary bends. Do not use bends with curves of under 8-inch radius.

When copper or aluminum cable is used, make necessary joints with strong fittings that will permanently connect the parts without soldering.

Fasten conductors with single- or double-nail strap fasteners. On masonry use brass screws set in masonry anchors (fig. 7). To make a neat and durable installation, space fasteners about 3 feet apart.

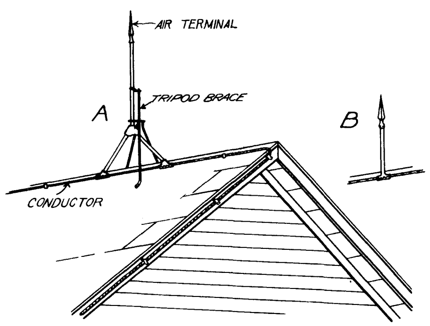

Figure 3.—*A*, Tripod brace supporting a long air terminal. *B*, Short air terminal clamped directly to conductor cable.

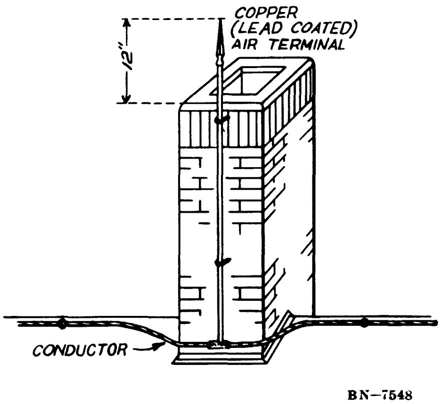

Figure 4.—**Air terminal installed on a chimney.**

Metal roofs or building walls can serve as part of the conductor system only if there are no breaks in their construction that would prevent them from being electrical conductors.

Branch conductors, usually made of conductor material of smaller diameter, should connect all structural metal parts of the building with the main conductor system. Use branch conductors to interconnect roof vent pipes that are within 6 feet of any conductor, and also to interconnect stanchions, litter tracks, haytracks, guy wires, door tracks, and stationary farm apparatus to the main conductor system.

Arresters

Secondary lightning damage has become more prevalent with the increased usage of electricity. Lightning may enter buildings by way of the electric power wires which serve the structure.

Properly designed lightning arresters placed between the power circuit and ground where the circuit enters the building will give a high degree of protection.

Such arresters should be installed in accordance with manufacturer's recommendations. Arresters should be adequately grounded. If electric wires are brought to several buildings separated from each other, it is desirable to provide arresters for each building.

Separate grounds should be provided for each arrester. If a good ground system has been provided for the lightning rod system, the lightning arrester grounds may be connected to such a ground system.

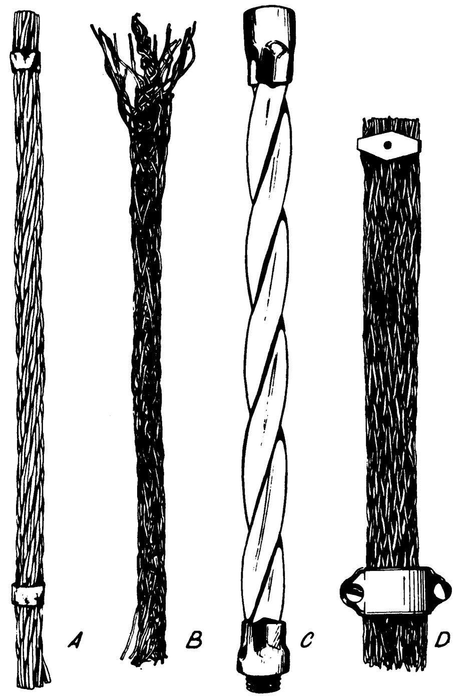

Figure 5.—**Common types of conductors. *A,* Twisted cable. *B,* Braided cable. *C,* Star-section rod. *D,* Flat cable.**

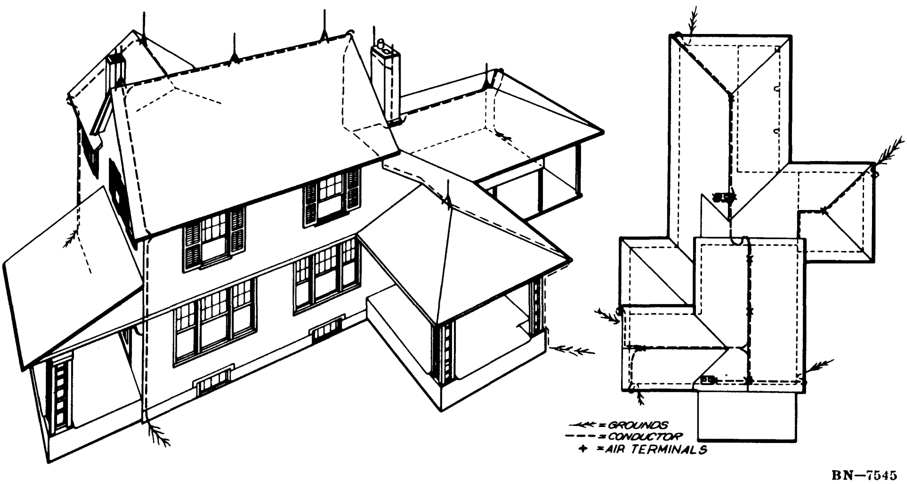

Figure 6.—**Conductor courses on a farmhouse installation.**

When lightning arresters are installed a periodic check should be made to determine the possibility of leakage of electrical energy. This check should be made by a qualified electrician who has the proper equipment required to measure the flow of current.

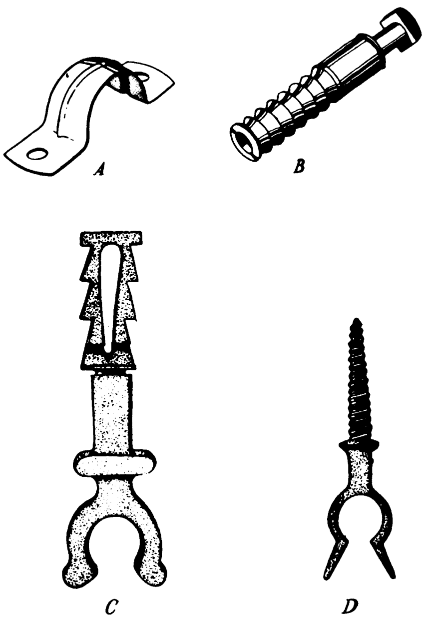

Figure 7.—Several types of conductor fasteners. A, Pipe strap. B, Masonry anchor. C, Masonry anchor. D, Screw fastener.

Ground Connections

Ground connections are of vital importance to the operation of the lightning-protection system. Make the ground connection properly; it is the key to the efficiency of the whole system.

At least two ground connections are usually needed for every lightning-protection system. They should be spaced as far apart as possible. They should also extend below and away from building foundations to prevent damage to walls from lightning discharge.

Ground connections are made in one of four ways: By driving a copper-clad or galvanized steel rod at least 10 feet into the ground, or by stranding copper conductor cable and burying it in a trench, or by clamping copper conductor cable to a buried sheet metal plate (fig. 8), or to a water pipe. The chief requirement is to get the lightning-

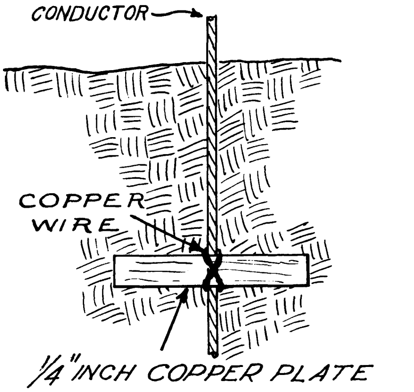

Figure 8.—**Ground made by burying a plate of sheet copper.**

protection system into good and permanent connection with moist earth. Never try to ground a conductor by putting a short length of it into the earth; this does not give enough electrical contact.

Determine the character of the soil in which the ground is to be made. Test moisture conditions at various locations around the building, taking into consideration the dryness or wetness of the season at the time. Select the more moist locations for making ground connections.

Avoid soil or chemical substances that will corrode the ground connection. Heavily galvanized steel resists corrosion for long periods in soil. Copper and copper-clad steel resist corrosion indefinitely in soil that is relatively free from ammonia.

Do not use aluminum for ground connections; it corrodes in soil.

Do not paint ground connections. Painting reduces their electrical conductivity.

If it is not practical to reach permanently moist earth, increase the area of the ground connection by extending the metal horizontally under the soil, or by using several grounds extending radially away from the point of entry into the ground. Other alternatives are to increase the number of ground connections or to run a ground entirely around the building with all conductors connected to it.

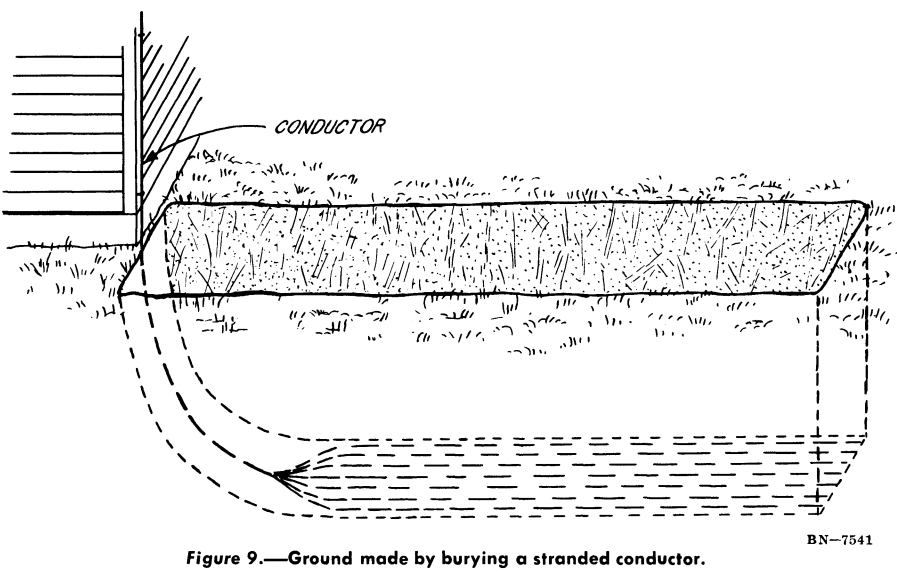

Figure 9.—**Ground made by burying a stranded conductor.**

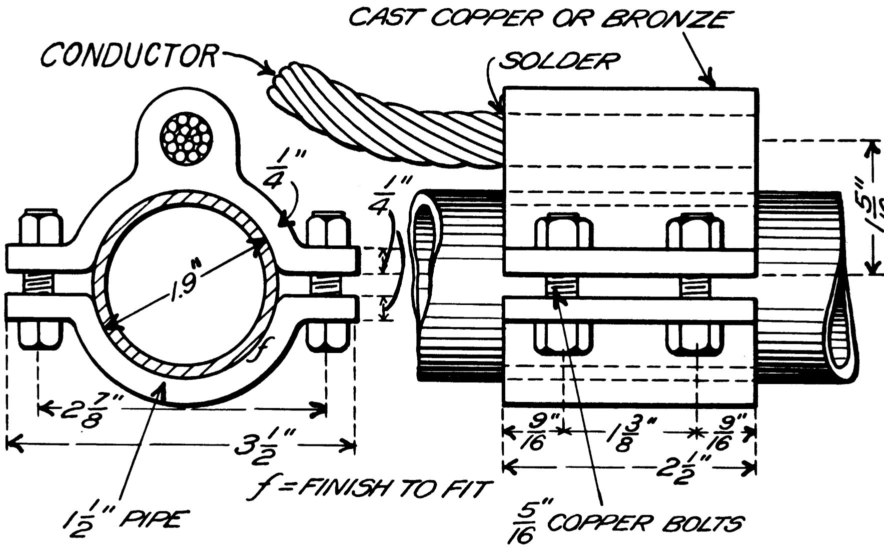

Figure 10.—Pipe clamp ground.

Where soil conditions do not permit driving or digging to a sufficient depth, make a ground by burying a copper cable in a trench running away from the building (fig. 9). For a depth of 5 feet make the trench 15 feet long; for a depth of 4 feet make it 20. Make shallower trenches proportionately longer.

Cover the trench floor with a 5-inch layer of pea-sized charcoal, which will help the grounding ability of the cable. Untwist the cable and spread the strands over the charcoal. Cover the strands with another 5 inches of charcoal and fill the trench in with soil. The ground may be improved still more by splicing another cable to the conductor cable near the point of entry into the ground, and then spreading these additional strands in the same or another trench.

Connections to water piping where it enters a building generally make the best ground available. Make connections to water pipes with a strong clamp (fig. 10). Individual deep-well casings are excellent for ground connections.

Connect aluminum conductor cable to copper or steel ground connections with clamps designed for the purpose; otherwise connections are likely to corrode. Make these conductor-to-ground joints within a foot of the ground level.

Use a wooden housing to protect conductors and ground connections from damage by livestock.

After the ground connection is installed and connected with the whole system, have it tested for electrical resistance. Any competent lightning-protection system installer has an instrument for testing grounds. The meter readings should be very low on the scale for a ground connection in good condition: under 5 ohms is excellent; between 5 and 25 ohms is very good; and between 25 and 50 ohms is good.

PROTECTION FOR LIVESTOCK

Livestock are usually killed instantly when they are near a fence that receives a lightning discharge. An ungrounded or improperly grounded wire fence can carry some of the electric current from the lightning discharge along its wires as far as 2 miles. Wire fences that are attached to trees or buildings are most likely to receive and carry lightning discharges, but any ungrounded wire fence with wooden posts, or steel posts set in concrete, is a hazard to livestock.

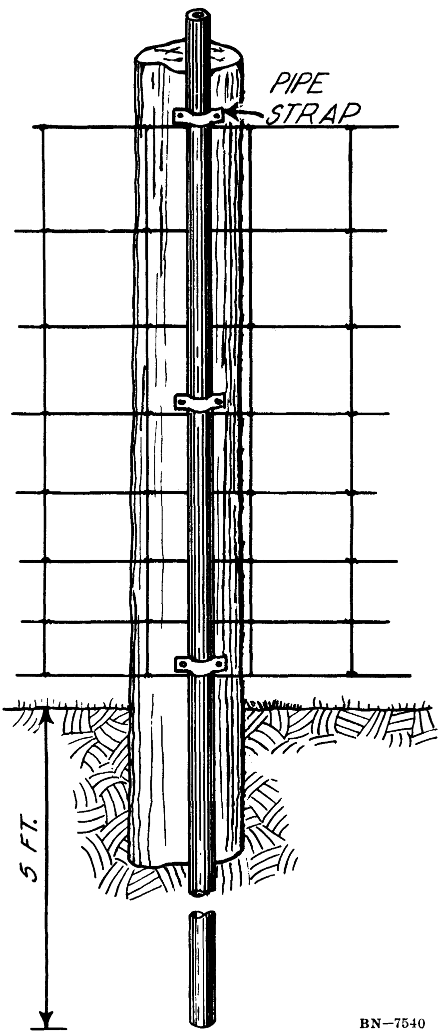

Figure 11.—Length of pipe used to ground a fence.

Ground wire fences to avoid this hazard. Use posts of galvanized steel at intervals of about 150 feet along the fence.

Another way to ground wire fences is to use pieces of ½- or ¾-inch galvanized steel rod or pipe. Drive these pieces about 5 feet into the earth alongside the wooden fenceposts at about 150-foot intervals. Allow a few inches of pipe or rod to extend above each post. Fasten these pipes or rods to the posts with pipe straps so that they touch all the fence wires (fig. 11).

PROTECTION FOR TREES

Trees are often ruined or severely damaged by lightning. This is hazardous because the lightning discharge is transmitted to nearby areas. Also, if the tree is sufficiently damaged it may fall on a building.

Trees that especially need protection are those that are higher than nearby farm buildings. Other trees that should be protected are those under which livestock usually shelter in a storm and those that are individually valuable.

Protect a tree by installing one or more 10-inch air terminals at the highest secure part of the tree and grounding them through conductors. Very large trees may need two conductors and several air terminals.

Mount the conductors with long-shanked screw fasteners to keep the conductors from contact with the

tree when a lightning discharge is being carried in the system.

Where there is a small group of trees, only a few of the tallest need to be protected. If a grove of trees is available for the livestock, remove isolated trees from the pasture, or fence them off to prevent the stock from sheltering under them in a storm.

To make a ground connection, dig a trench and bury the unraveled end of the conductor cable in it. Make the trench shallow near the tree to prevent damage to the roots. Make it slant downward away from the base of the tree so as to reach moist soil (fig. 12).

To protect the exposed part of the conductor from damage by the livestock, cover it with a wooden casing.

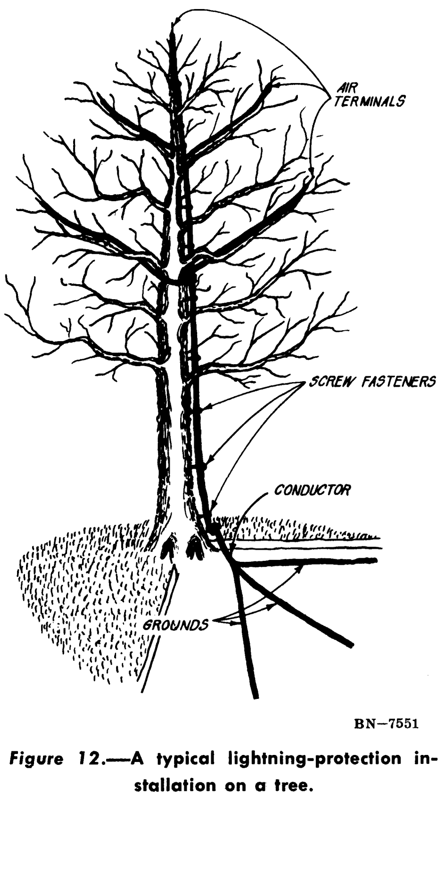

Figure 12.—A typical lightning-protection installation on a tree.

INSTALLATION

Generally, it will be necessary to have an expert plan and install a lightning-protection system. Few persons have the equipment and skill to install and to test their own lightning-protection systems. The farmer should know, however, what the proper materials are and the methods used in the installation.

Follow the work carefully, especially the ground-connection installation. All ground connections should be tested with special equipment to make sure that they are adequate for lightning-protection requirements.

Reputable contractors guarantee their work; many of them will inspect the installation periodically.

Use materials approved by Underwriters' Laboratories, Inc. All such materials are clearly labeled.

Follow installation methods described in detail in the Code for Protection Against Lightning, published by the National Bureau of Standards, or in Installation Requirements for Master Labeled Lightning Protection Systems, published by Underwriters' Laboratories, Inc.

INSPECTION AND MAINTENANCE

Make a periodic inspection of your lightning-protection system to be sure it is in working order.

Look for bent, loose, or missing air terminals, broken conductor cables, and loose connecting clamps. If new construction has been added since the lightning-protection sys-

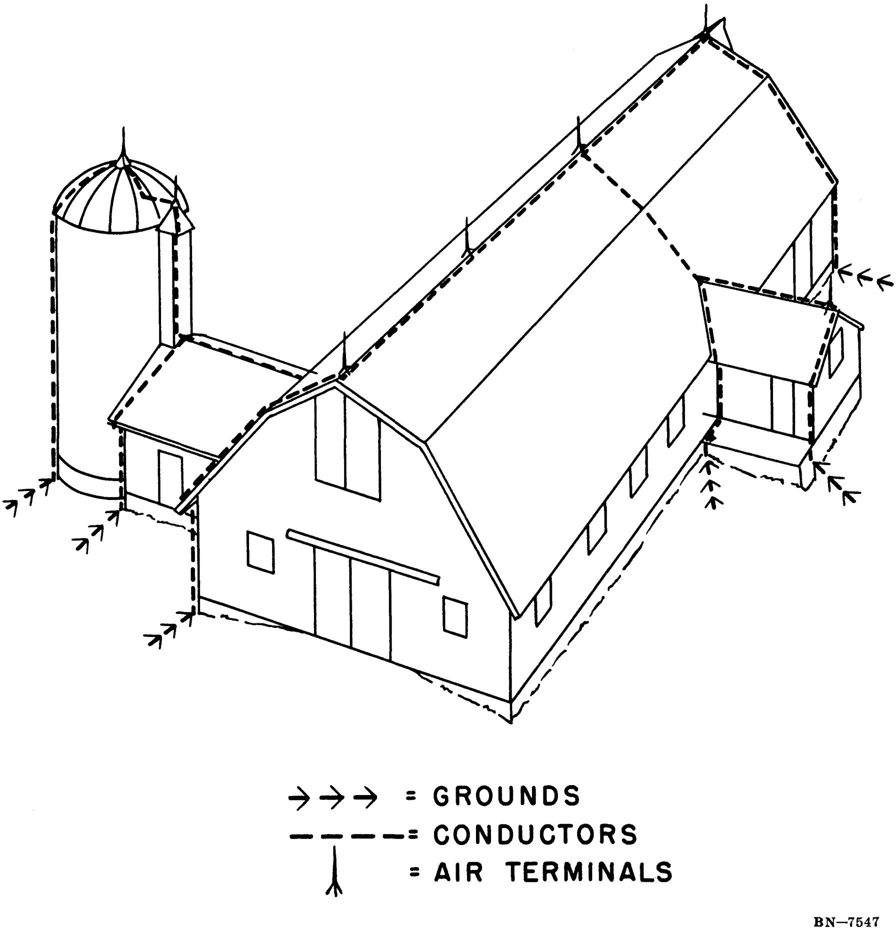

***Figure 13.*—Lightning-protection system installation for a barn with silo.**

tem was installed, check to see that it has been interconnected with the system.

PERSONAL SAFETY

Do not go outdoors or stay outdoors during thunderstorms unless absolutely necessary. If you are caught outdoors, seek shelter in a cave. You may also take shelter in a deep valley or at the foot of a steep cliff, but guard against being caught by flash floods following the storm.

If a shelter is not available, lie down in any low spot in the ground.

Do not stay near isolated trees, wire fences, or small sheds in exposed locations. Keep off hilltops and open pastures or fields.

If you are in a truck or an automobile, stay inside.

If you are indoors, and the building does not have a lightning-protection installation, keep away from fireplaces, stoves, and other metal objects.

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